TIA/EIA TELECOMMUNICATIONS SYSTEMS BULLETIN

Interference Criteria for Microwave Systems

TSB10-F

(Revision of TSB10-E)

JUNE 1994

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TELECOMMUNICATIONS TIA INDUSTRY ASSOCIATION

Representing the telecommunications industry
in association with the Electronic Industries Association

ELECTRONIC INDUSTRIES ASSOCIATION EIA EST 1924

Wireless Strategies Inc. **November 14, 2007**

Examples

The subsequent examples follow the format given in TSB10-F, and the appropriate general comments of Section 3 apply.

Example 1.

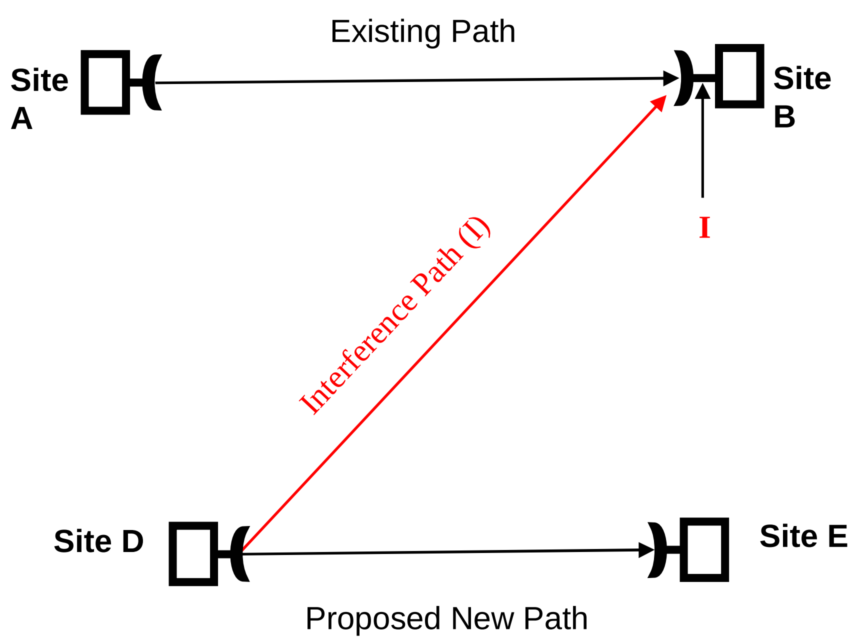

Figure 1 (Same as TSB10 Figure 3.3)

P_D	=	+33dBm	Interfering transmit power
G_D	=	38dBi	Interfering transmit antenna gain
W_D	=	2dB	Interfering transmit transmission line loss
$EIRP_D$	=		$(P_D + G_D - W_D)$
	=		$(33 + 38 - 2) = 69$dBm
G_B	=	43dBi	Victim receiver antenna gain
W_B	=	2dB	Victim receiver transmission line loss
L_{DB}	=	146dB	DB = 44 mile interfering path free-space loss
W_D	=	2dB	Interfering transmit transmission line loss
M_D	=	33dB	Interfering transmit antenna discrimination
M_B	=	36dB	Victim receive antenna discrimination
T	=	- 75dBm	Victim receiver threshold
I_M	=	-100dBm	Maximum allowed interference at the input of the victim receiver
I	=		Interference level at the input of the victim receiver from the source antenna system, in dBm
	=		$P_D + G_D - W_D + G_B - W_B - L_{DB} - M_D - M_B$, dBm

On Page 3 – 13, Section 3 of TSB10-F it states: "The only calculation required is to determine the interfering signal level at the victim receiver's input," therefore:

I = 33 + 38 – 2 + 43 - 2 – 146 - 33 – 36 = -105 dBm

This interference case will clear by 5dB (-100dBm – (-105dBm)).

The above calculation and result apply to all antenna types including a dumb parabolic dish antenna system with a single passive element or a smart antenna system with multiple active elements, because the interference (I) is the highest level of interference at the victim receiver's input from the source antenna system.

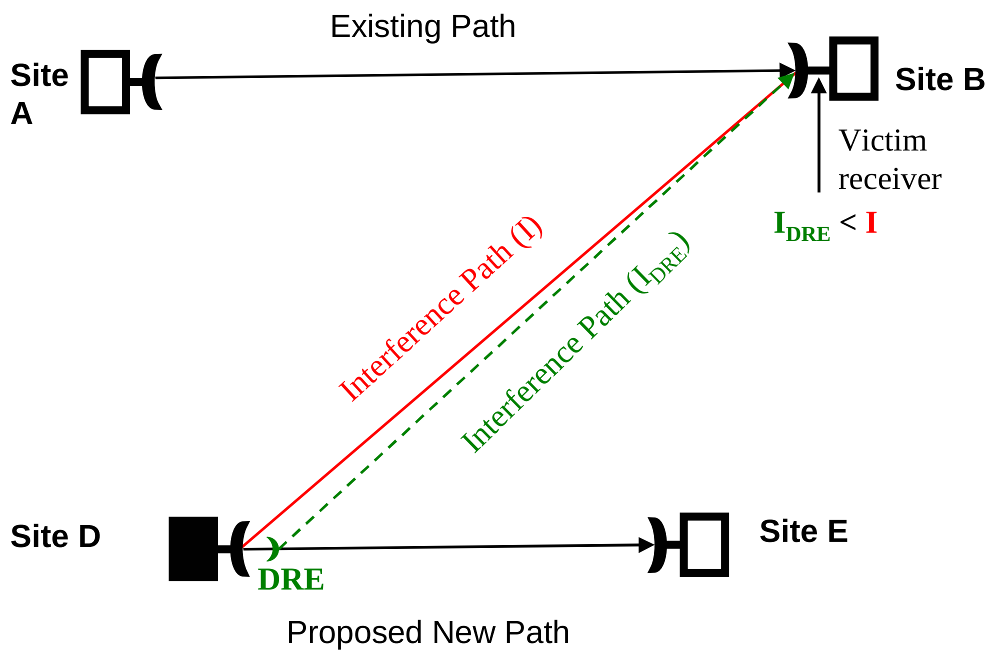
Existing Path
Site A
Site B
Victim receiver
I_{DRE} < I
Interference Path (I)
Interference Path (I_{DRE})
Site D
DRE
Site E
Proposed New Path

Figure 1a

As all the coordination information for all paths -- licensed or pending -- is known, a smart antenna with distributed radiators can ensure that the interference from any distributed element (I_{DRE}) of the source antenna system arriving at the input of any victim receiver is always less than the source antenna system's highest level of interference (I) arriving at the victim receiver's input or 6dB below the victim receiver's thermal noise (I_T).

Figure 1a shows a smart antenna system at Site D with a distributed radiating element (DRE) located one mile in front of Site D in-line with Site E. The smart antenna knows the characteristics of its DRE's (all adaptive) and that in this example, the desired EIRP towards Site D from the DRE is 5dBm with an EIRP toward Site B of -40dBm.

Because the smart antenna system has all the coordination data loaded into the system, it knows the differential gain of the antenna at Site B and all the other information to calculate the interference at the victim receiver from any DRE. In this case,

$$I_{DRE} = -40 + G_B - W_B - L_{DB} - M_B$$

$$= -40 + 43 - 2 - 146 - 36 = -181\text{dBm}$$

This meets the requirement that I_{DRE} < I by 76dB (-105 – (-181))

Therefore, the frequency of the proposed path can be reused between Site D and the DRE without having any effect on path coordination results.

Example 2.

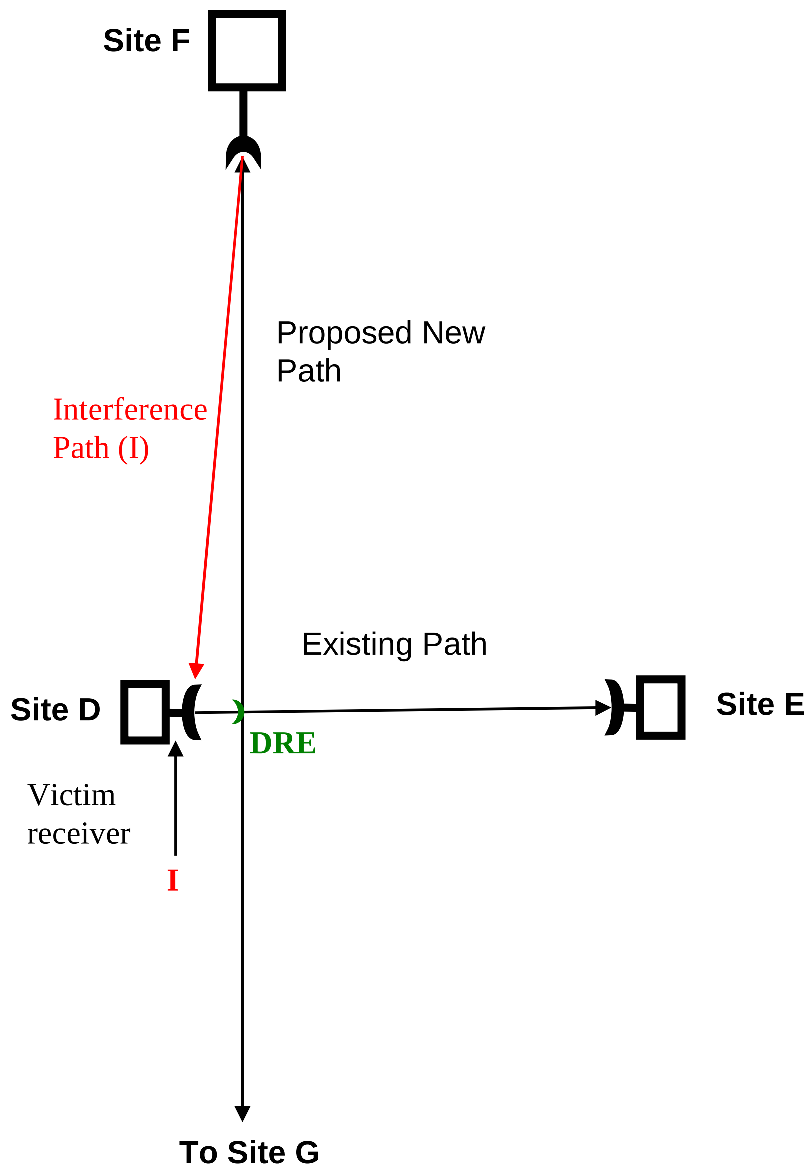

Figure 2

Figure 2 shows a proposed path Site F to Site G where Site F is located nine miles from Site D intersecting the existing path at a right angle one mile from Site D. The Site F antenna has a gain of 46dBi and P_F is 33dBm.

P_D	=	+33dBm	Existing transmit power
G_D	=	38dBi	Existing transmit antenna gain
W_D	=	2dB	Desired transmit transmission line loss
$EIRP_D$	=		$(P_D + G_D – W_D)$
	=		(33 + 38 – 2) = 69dBm
P_F	=	+33dBm	Interfering transmit power
G_F	=	46dBi	Interfering transmit antenna gain
W_F	=	2dB	Interfering transmit transmission line loss
$EIRP_F$	=		$(P_F + G_F – W_F)$
	=		(33 + 46 – 2) = 77dBm
G_D	=	38dBi	Victim receiver antenna gain
W_D	=	2dB	Victim receiver transmission line loss
L_{FD}	=	132dB	FD = 9 mile interfering path free-space loss
W_D	=	2dB	Interfering transmit transmission line loss
M_F	=	26dB	Interfering transmit antenna discrimination
M_D	=	42dB	Victim receive antenna discrimination
T	=	-75dBm	Victim receiver threshold
I_M	=	-100dBm	Maximum allowed interference at the input of the victim receiver
I	=		Interference level at the input of the victim receiver from the source antenna system, in dBm
	$=P_F + G_F - W_F + G_D – W_D - L_{FD} – M_F – M_D$, dBm		

On Page 3 – 13, Section 3 of TSB10-F it states, “The only calculation required is to determine the interfering signal level at the victim receiver’s input.” Therefore:

I = 33 + 46 – 2 + 38 - 2 – 132 - 26 – 42 = -87 dBm

Missing the interference margin by 13dBm (-100dBm – (- 87dBm)).

However, the new applicant advises the licensee, or their coordination service provider, that there is a 14dB obstruction loss between Site F and Site D, therefore the interference case will clear by 1dB. As previously stated, this calculation applies for any type of antenna system at Site D, dumb or smart.

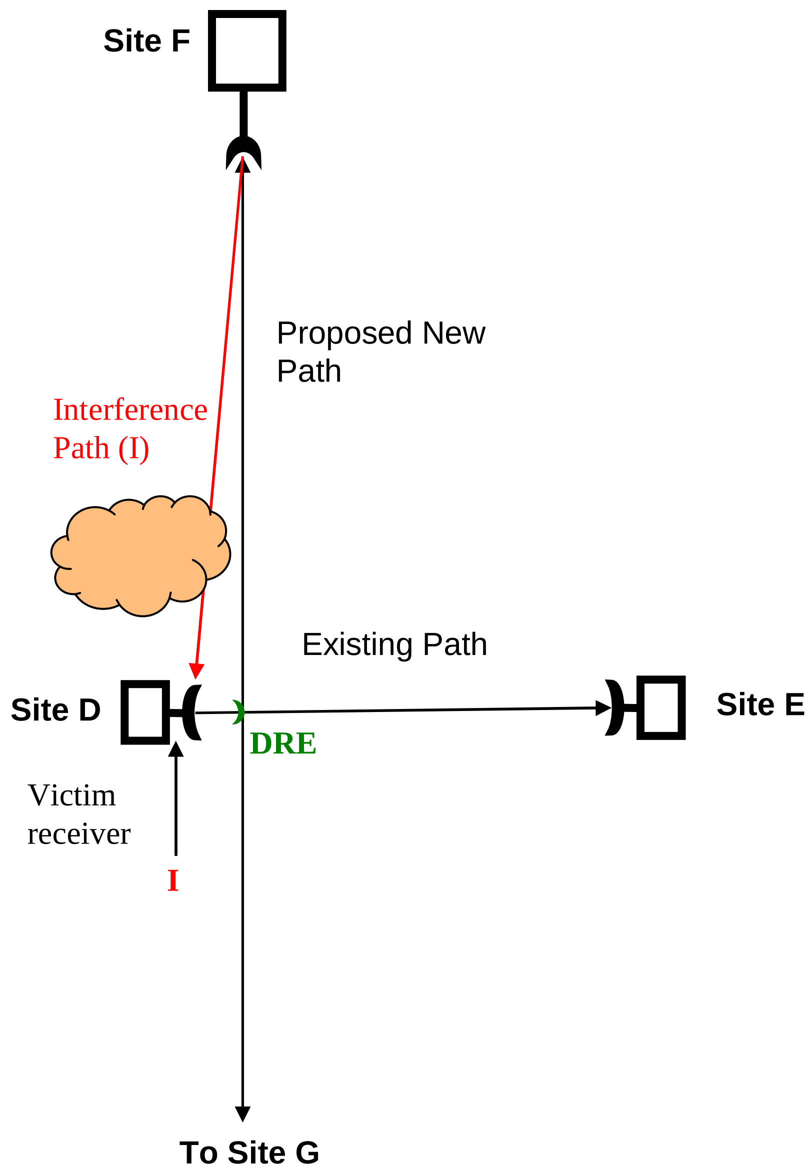

Figure 2a

Using the reciprocity theorem the accepted interference (I) at Site F from Site D is -101dBm

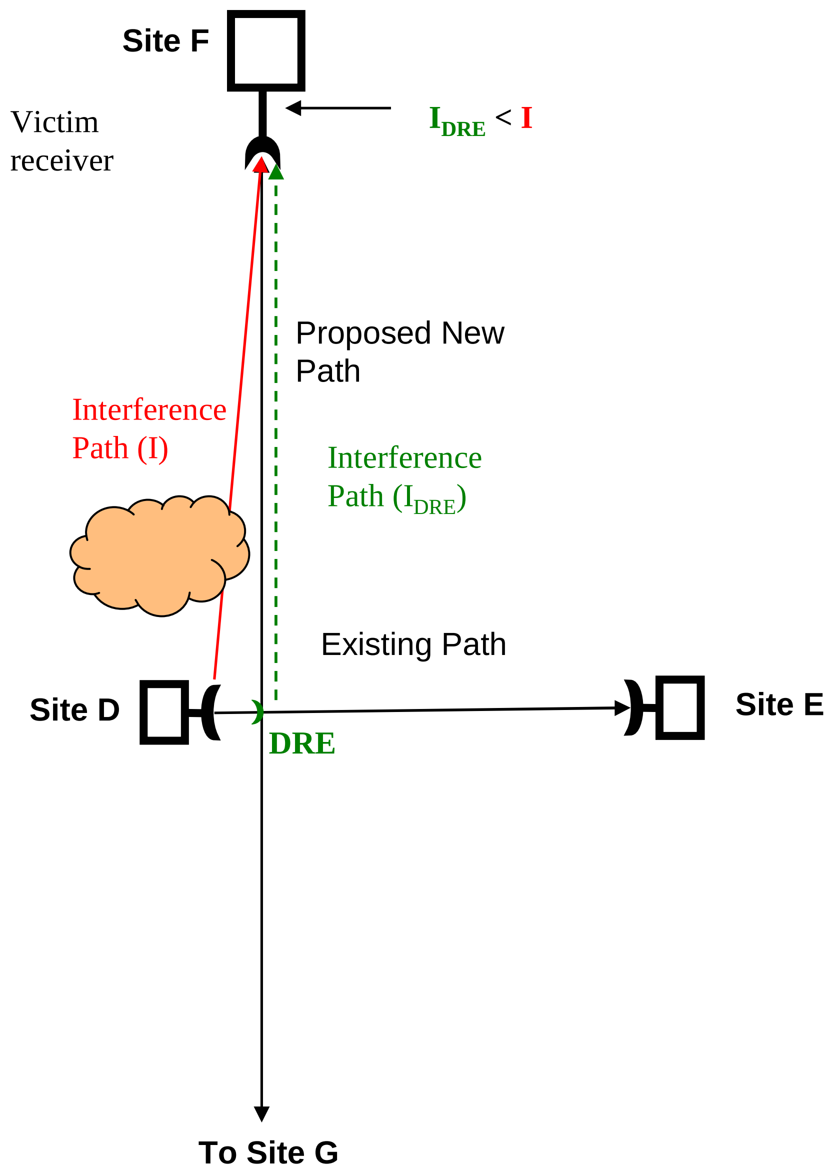

Figure 2b

Figure 2b shows the system using a smart antenna with a DRE at the path intersect. The smart antenna knows the characteristics of all of its fully adaptive DRE's, including this DRE, and that in this example, the desired EIRP towards Site D from the DRE is 5dBm with an EIRP towards Site F of -37dBm.

As all the coordination information for all paths -- licensed or pending -- is known, the smart antenna can ensure that the interference from any distributed element (I_{DRE}) of the source antenna system arriving at the input of any victim receiver is always less than the source antenna's highest level of interference (I) arriving at the victim receiver's input or 6dB below the victim receiver's thermal noise (I_T).

Also, the smart antenna knows that the accepted interference level at Site F from Site D, after the obstruction loss of 14 dB, is -101dBm. Assuming a worst-case scenario of no obstruction loss from the DRE towards Site F, then I_{DRE} at the input of the receiver at Site F is given by :

$$I_{DRE} = -37 + G_F - W_F - M_F - L_{FDRE}$$

$$= -37 + 46 - 2 - 0 - 132 = -125\text{dBm}$$

This meets the requirement that $I_{DRE} < I$ by 24dB (-101dBm – (-125dBm))

Therefore, the reused frequency of the existing path will have no effect on path coordination results and conclusions.

Example 3.

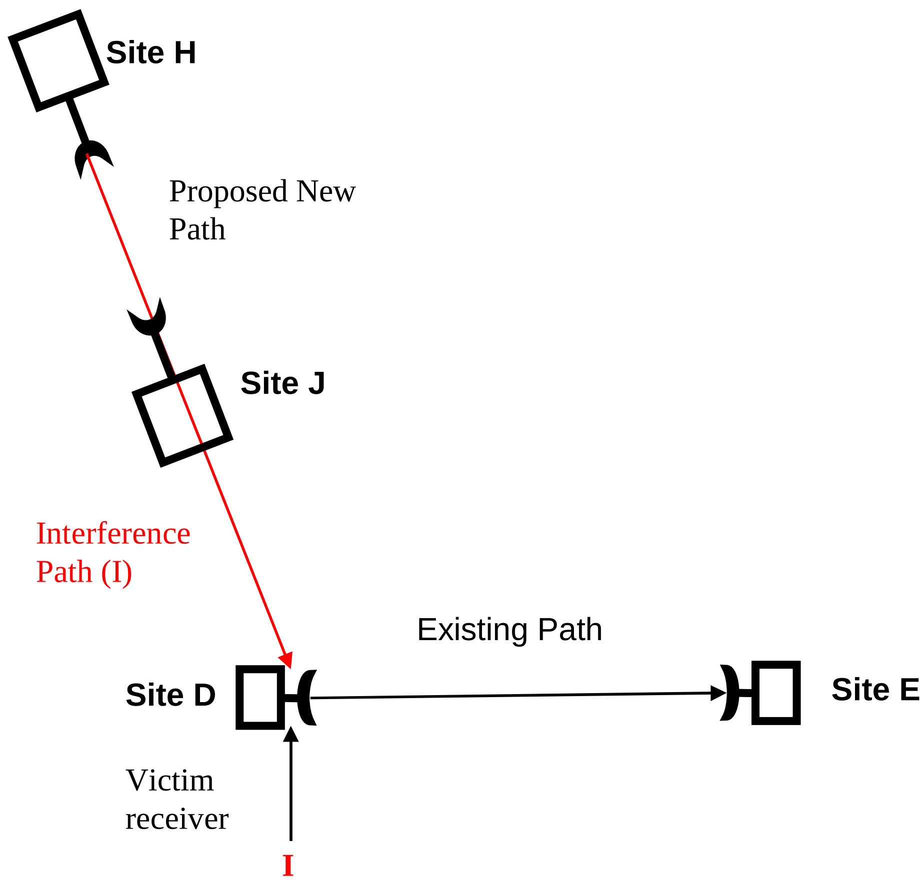

Figure 3

In this example Site D to Site E is the existing path. Figure 3 shows a proposed path Site H to Site J where Site H is located one hundred and twenty miles from Site D and is pointed into the rear of the Site D antenna at an angle off the existing path of 95 degrees. The Site H antenna has a gain of 38dBi and the P_H is 20dBm.

P_D	=	33dBm	Existing transmit power
G_D	=	38dBi	Existing transmit antenna gain
W_D	=	2dB	Existing transmit transmission line loss
$EIRP_D$	=		$(P_D + G_D – W_D)$
	=		(33 + 38 – 2) = 69dBm
P_H	=	20dBm	Interfering transmit power
G_H	=	38dBi	Interfering transmit antenna gain
W_H	=	2dB	Interfering transmit transmission line loss
$EIRP_H$	=		$(P_H + G_H – W_H)$
	=		(20 + 38 – 2) = 56dBm
G_D	=	38dBi	Victim receiver antenna gain
W_D	=	2dB	Victim receiver transmission line loss
L_{DH}	=	154dB	FD = 120 mile interfering path free-space loss
W_H	=	2dB	Interfering transmit transmission line loss
M_H	=	0dB	Interfering transmit antenna discrimination
M_D	=	42dB	Victim receive antenna discrimination
T	=	- 75dBm	Victim receiver threshold
I_M	=	-100dBm	Maximum allowed interference at the input of the victim receiver
I	=		Interference level at the input of the victim receiver from the source antenna system, in dBm

$= P_H + G_H - W_H + G_D – W_D - L_{DH} – M_H – M_D$, dBm

On Page 3 – 13, Section 3 of TSB10-F it states, "The only calculation required is to determine the interfering signal level at the victim receiver's input." Therefore:

I = 20 + 38 – 2 + 38 - 2 – 154 - 0 – 42 = -104dBm

The interference case will clear by 4dB (100- (-104)).

As previously stated, this calculation applies for any type of antenna system at Site D, dumb or smart.

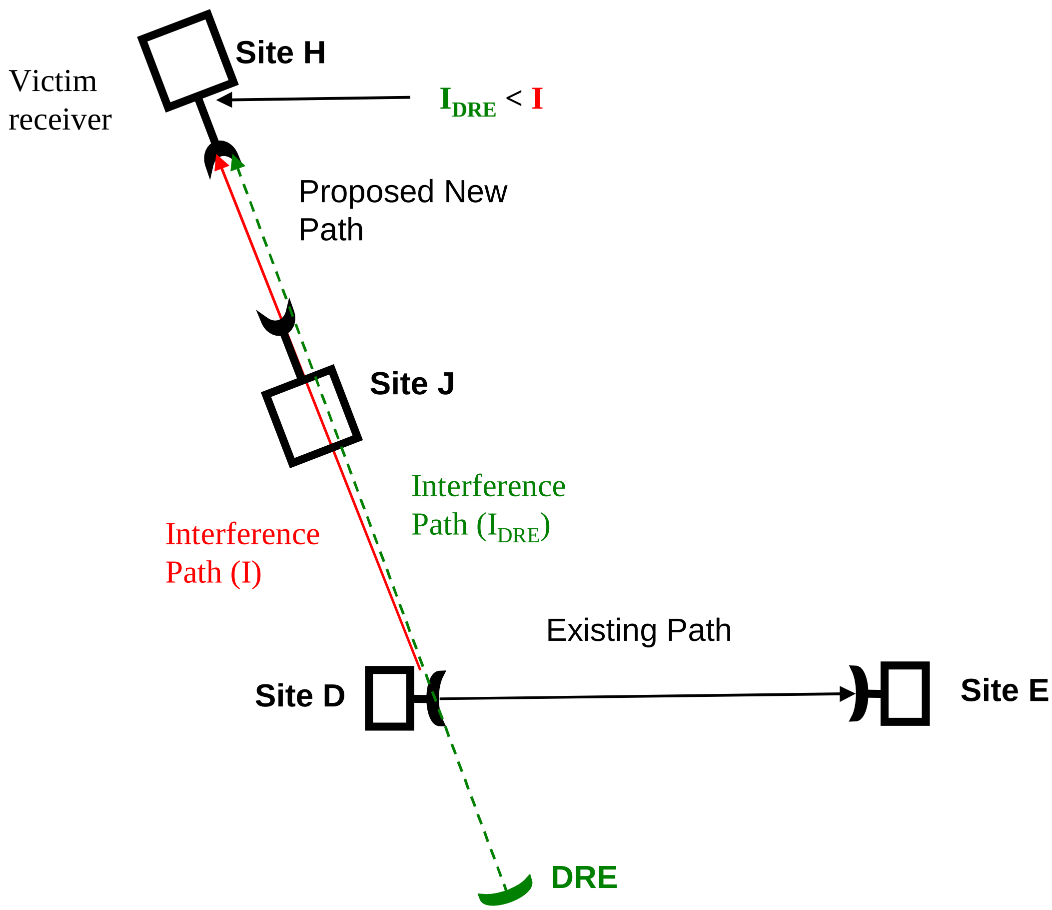
Site H
Victim receiver
$I_{DRE} < I$
Proposed New Path
Site J
Interference Path (I_{DRE})
Interference Path (I)
Existing Path
Site D
Site E
DRE

Figure 3a

Figure 3a shows a system with a DRE one thousand feet from Site D at an angle of 265 degrees off of the existing path (pointing directly at Site H). The smart antenna knows the characteristics of its DRE's (all adaptive) and that in this example, the desired EIRP toward Site D from the DRE is 13dBm.

As all the coordination information for all paths -- licensed or pending -- is known, the smart antenna can ensure that the interference from any distributed element (I_{DRE}) of the source antenna system arriving at the input of any victim receiver is always less than the source antenna's highest level of interference (I) arriving at the victim receiver's input or 6dB below the victim receiver's thermal noise (I_T).

Also, the smart antenna knows that the accepted interference level at Site H from Site D is:

$$I = P_D + G_D - W_D + H_D - W_H - L_{DH} - M_H - M_D$$

$$= 33 + 38 - 2 + 38 - 2 - 154 - 0 - 42 = -91\text{dBm}$$

The interference level (I_{DRE}) at the input of the receiver at Site H is given by

$$I_{DRE} = 13 + G_H - W_H - M_H - L_{FDRE1}$$

$$= 13 + 38 - 2 - 0 - 154 = -105\text{dBm}$$

Meeting the requirement $I_{DRE} < I$ by 14dB (-105dBm – (-91dBm)).

Therefore, the reused frequency of the existing path will have no effect on path coordination results and conclusions.

Conclusion

In the last century, fixed microwave links used dumb antenna systems, such as a parabolic dish, with a continuously-on carrier. This resulted in a static, non-optimized, non-adaptive set of operating parameters.

Emerging technologies make possible smart antenna systems operating time division, totally adaptive and therefore capable of optimizing the operating parameters to increase the effective use of spectrum.

The examples have shown that all frequency coordination equations and procedures apply equally to paths designed with dumb and smart antenna systems because interference at the input of an existing or proposed receiver from a smart antenna's distributed radiating element or elements will have no effect on path coordination results or conclusions. This allows for licensed frequencies to be reused by the licensee without causing harmful interference, making it possible for the licensee to make more effective use of the authorized spectrum.

Conclusion

- **All FCC regulations and procedures are in place**

- **A licensee must comply with all regulations and follow all required procedures**

- **New license applicants have all the information necessary to conduct a prior coordination**

- **The Smart Antenna's database can be maintained by the licensee or out-sourced to a coordination representative.**

Applications

Wireless Strategies Inc

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